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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>A61N 5/06</b>		<b>A1</b>	(11) International Publication Number: <b>WO 97/46280</b>
			(43) International Publication Date: 11 December 1997 (11.12.97)
(21) International Application Number: PCT/SE97/00978		(81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).	
(22) International Filing Date: 4 June 1997 (04.06.97)			
(30) Priority Data: 9602273-6 7 June 1996 (07.06.96) SE			
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		In English translation (filed in Swedish).	
(54) Title: DEVICE FOR EXTERNAL TREATMENT WITH PULSATING LIGHT OF HIGH DUTY CYCLE			
(57) Abstract			
<p>Apparatus for external medical treatment with light, comprising a light-emitting device which is intended to lie against or to be held in the close proximity of the body of an individual, and a drive device for driving the light-emitting device, wherein the light-emitting device includes light-emitting diodes or corresponding elements and is adapted to emit monochromatic light of a first wavelength, wherein the drive device (8, 9, 10) is adapted to cause the light-emitting device (1) to emit the monochromatic light over a first predetermined time period in a first stage and thereafter emit selectively monochromatic light of a different wavelength than the first wavelength over a second predetermined time period in a possible second stage, and wherein the drive device (8, 9, 10) is adapted to cause the light-emitting device (1) to pulsate the emitted light in accordance with a predetermined pulse frequency or series of pulse frequencies over the time periods. The invention is characterized in that the drive device (8, 9, 10) is adapted to cause the light-emitting devices to emit the pulsating light with a pulse length that lies within an interval of about 60 % to 90 % of the time between respective start edges (18, 19) of two mutually sequential pulses (15).</p>			
<p>The graph plots 'Medical effect per time unit' on the y-axis (0 to 120) against 'Pulse length % of (pulse + pause) interval' on the x-axis (0 to 100). A solid curve rises from (0,0) to a peak of approximately 100 at 80% pulse length, then falls to 0 at 100%. Two horizontal dashed lines are drawn at y=60 and y=80. Vertical dashed lines drop from the curve at these levels to the x-axis, indicating pulse lengths of approximately 60% and 90% respectively.</p>			

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## DEVICE FOR EXTERNAL TREATMENT WITH PULSATING LIGHT OF HIGH DUTY CYCLE

The present invention relates to apparatus for external medical treatment with light, and more specifically light  
5 that will alleviate and/or cure different sicknesses, illnesses, diseases, etc., hereinafter referred to as health disorders.

10 It has been found that infrared light has a favourable effect in this regard.

Swedish Patent Specification No. 502 784 teaches apparatus for external medical treatment with light, comprising a  
15 light-emitting device which is intended to lie against or be held in the close proximity of the body of an individual, and drive means for driving the light-emitting device, wherein the light-emitting device includes light-emitting diodes or corresponding light-emitting elements and is adapted to emit  
20 infrared light. The invention according to this patent is mainly characterized in that the drive device is adapted to cause the light-emitting device to emit light over a predetermined period of time in a first stage, and thereafter to emit visible light over a second predetermined period of time  
25 in a second stage; and in that the drive device is adapted to cause the light-emitting device to pulsate the emitted infrared light and the visible light respectively in accordance with a predetermined series of pulse frequencies.

30 It has been found that such apparatus can be used very successfully in the treatment of other disorders and injuries, for instance injuries sustained in sporting activities, pulled or strained muscles, muscular pain, joint pains, headaches, different inflammatory conditions, different skin  
35 complaints, such as acne, back pains, etc., provided that the light is emitted in a certain way. Treatment with light has a favourable effect on the healing of injuries and will alleviate and/or cure various health disorders.

Thus, it is realized that treatment with light in which a certain light is emitted in a certain series of frequencies will have a significantly greater effect with respect to shortening the time taken to cure or alleviate a health disorder.

It has also been found that treatment with solely one or more monochromatic lights other than infrared light, such as visible light of different colours, emitted in accordance with a certain pulse frequency gives a very good treatment result.

The present invention is based on the insight that the pulse length of emitted pulsating light of a given pulse frequency has a great effect on the result of the treatment.

The present invention thus relates to apparatus for external medical treatment with light, wherein the apparatus includes a light-emitting device which is intended to lie against or to be held in the close proximity of the body of an individual, and a drive device for driving the light-emitting device, wherein the light-emitting device includes light-emitting diodes or corresponding elements and is adapted to emit monochromatic light of a first wavelength, wherein the drive device is adapted to cause the light-emitting device to emit said monochromatic light over a predetermined first time period in a first stage, and thereafter to emit selectively monochromatic light of a different wavelength to the first wavelength over a second predetermined time period in a possible second stage, and wherein the drive device is adapted to cause the light-emitting device to pulsate said emitted light in accordance with a predetermined pulse frequency or series of pulse frequencies over said time periods, and wherein the apparatus is characterized in that the drive device is adapted to cause the light-emitting devices to emit said pulsating light with a pulse length that lies within an interval of about 60% to 90% of the time

between respective start edges of two mutually sequential pulses.

5 The invention will now be described in more detail with reference to exemplifying embodiments thereof and also with reference to the accompanying drawings, wherein

- Figure 1 illustrates the inventive apparatus schematically and in block form;
- 10 - Figure 2 is a side view of a light-emitting device;
- Figure 3 is a diagram; and
- Figure 4 illustrates pulsed light.

15 Figures 1 and 2 illustrate apparatus for external medical treatment with the aid of light. The apparatus includes a light-emitting device 1, which is intended to lie against or to be held in the close proximity of the body of an individual. Figure 2 shows the light-emitting device from one side, while Figure 1 shows the element from beneath. The light-emitting device includes a housing 5 which is provided with  
20 a transparent plate 6. Located beneath the plate 6 is a surface 2 on which a plurality of light-emitting diodes 3, 4 or corresponding light-emitting elements are mounted. The light-emitting diodes send light through the plate 6 when the  
25 diodes are energized, i.e. supplied with current through a cable 7. In use, the housing 5 is held so that the plate 6 will lie against the relevant part of the body. The apparatus also includes drive means 8, 9, 10 for driving the light-emitting device 1. The light-emitting device 1 may include  
30 light-emitting diodes 3 or corresponding means for emitting infrared light. These diodes or the like are marked with solid circles in Figure 1.

35 The drive means 8, 9, 10 are adapted to cause the light-emitting device 1 to emit monochromatic light of a given wavelength over a predetermined time period. The drive means may also be adapted to emit monochromatic light of a wave-

length different to the first-mentioned wavelength over a second predetermined time period, in an optional second stage of the treatment. Visible light is emitted with the aid of light-emitting diodes 4 or corresponding elements. These diodes are marked with hollow circles in Figure 1.

The drive means 8, 9, 10 are also adapted to cause the light-emitting device 1 to emit pulsating light in accordance with a predetermined pulse frequency or a series of pulse frequencies over predetermined time periods. The drive means include a computer 8 which functions to control drive circuits 9, 10, to which voltage is applied for driving the light-emitting diodes via conductors 11, 12.

The computer and drive circuits are of an appropriate known kind. Connected to the drive means is a keyboard 13 by means of which the operator can enter drive means control data for actuating the light-emitting device in a desired manner. The apparatus will also conveniently include a display 14, on which the settings made through the keyboard are displayed.

Infrared light-emitting diodes 3 are preferably semi-conductor diodes of the GaAs kind (Gallium arsenide). The light-emitting diodes 4 that emit visible light are also preferably of the GaAs type.

For instance, the number of light-emitting diodes included in the light-emitting device may be such that the infrared light-emitting diodes will together generate a light power of 1800 milliwatts, and the diodes that emit visible light may each have a power of 3000 millicandela.

According to one embodiment of the invention, the light-emitting device 1 includes red light emitting diodes 4 that emit visible light at the wavelength of 660 nanometers and/or infrared light emitting diodes that emit light at the wavelength of 950 nanometers.

In another embodiment of the invention, the light-emitting device 1 includes light-emitting diodes 4 that emit a substantially monochromatic visible light in one of the colours violet, blue, yellow, orange, red or green.

5

The visible light used will depend on the disorder or type of injury to be treated.

10 The subject matter described above with reference to the accompanying drawings is essentially also found described in the aforementioned patent specification.

15 According to the invention, the drive device is adapted to cause the light-emitting device or elements to emit said pulsating monochromatic light at a pulse length that lies within an interval of about 60% to 90% of the time between respective start edges 18, 19 of two mutually sequential pulses 15.

20 Figure 4 is a schematic illustration of emitted light pulses, where amplitude  $V$  is shown on the Y-axis and time  $t$  on the X-axis. The duration of a pulse 15 is referenced 16 and the total pulse time plus a subsequent pause is referenced 17.

25 The medical effect per unit of time is shown on the Y-axis of the diagramme in Figure 3. This is a subjective measurement of the medical effect achieved, but is a result of tests of long duration and can therefore be considered highly reliable. The maximum value of the Y-axis is 100%. The X-axis  
30 shows the pulse length 16 as a percentage of the total time 17 of a pulse plus a subsequent pause, i.e. there is no pause between the pulses.

35 As Figure 3 surprisingly shows, the curve has a maximum at a value of about 79% on the X-axis, whereafter the curve falls steeply to zero with respect to medical effect.

The treatment interval is therewith relatively narrow, and lies between 60% and 90% on the X-axis. A medical effect of at lowest 60% is obtained within this interval.

5        However, the interval is narrower in accordance with one preferred embodiment. According to this preferred embodiment, the pulse length lies within an interval of about 67% to 88% of the time between respective start edges of two mutually sequential pulses, i.e. from 67% to 88% on the X-axis. The  
10       medical effect is at lowest 80% within this interval.

It will be evident that realization of the circumstances reflected in Figure 3 are of the greatest significance in the external medical treatment of disorders and injuries with  
15       light. The present invention thus provides considerable advances in this field. It should be mentioned that application of the present invention is not restricted to the treatment of patients in accordance with the prior patent publication mentioned in the introduction but can also be  
20       applied in the acupuncture treatment of patients with light as described in Swedish Patent Specification No. 9602272-8.

The present invention is not therefore restricted to the  
aforedescribed and illustrated exemplifying embodiments  
25       thereof, since modifications and variations can be made within the scope of the following Claims.



## CLAIMS

1. Apparatus for external medical treatment with light, comprising a light-emitting device which is intended to lie against or to be held in the close proximity of the body of an individual, and a drive device for driving the light-emitting device, wherein the light-emitting device includes light-emitting diodes or corresponding elements and is adapted to emit monochromatic light of a first wavelength, wherein the drive device (8, 9, 10) is adapted to cause the light-emitting device (1) to emit said monochromatic light over a first predetermined time period in a first stage and thereafter emit selectively monochromatic light of a different wavelength than said first wavelength over a second predetermined time period in a possible second stage, and wherein the drive device (8, 9, 10) is adapted to cause the light-emitting device (1) to pulsate said emitted light in accordance with a predetermined pulse frequency or series of pulse frequencies over said time periods, characterized in that the drive device (8, 9, 10) is adapted to cause said light-emitting devices to emit said pulsating light with a pulse length that lies within an interval of about 60% to 90% of the time between respective start edges (18, 19) of two mutually sequential pulses (15).

25

2. Apparatus according to Claim 1, characterized in that the pulse length lies within an interval of about 67% to 88% of the time between the respective start edges of two mutually sequential pulses.

Fig. 1

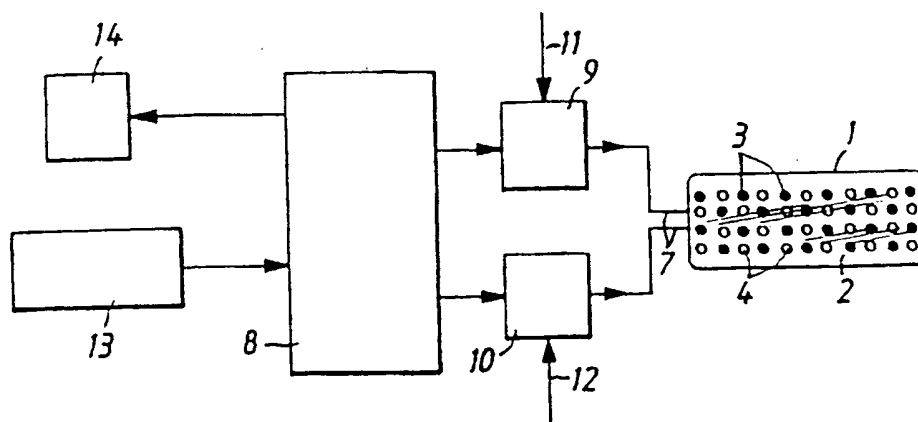
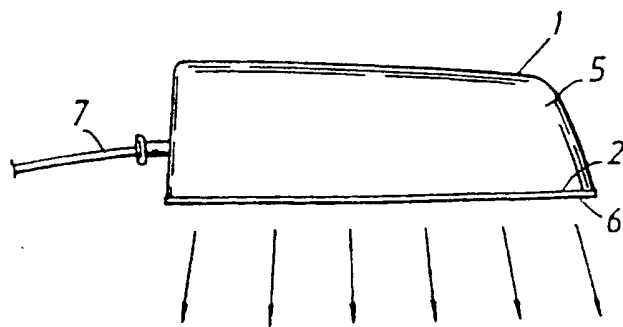


Fig. 2



2 / 2

Fig. 3

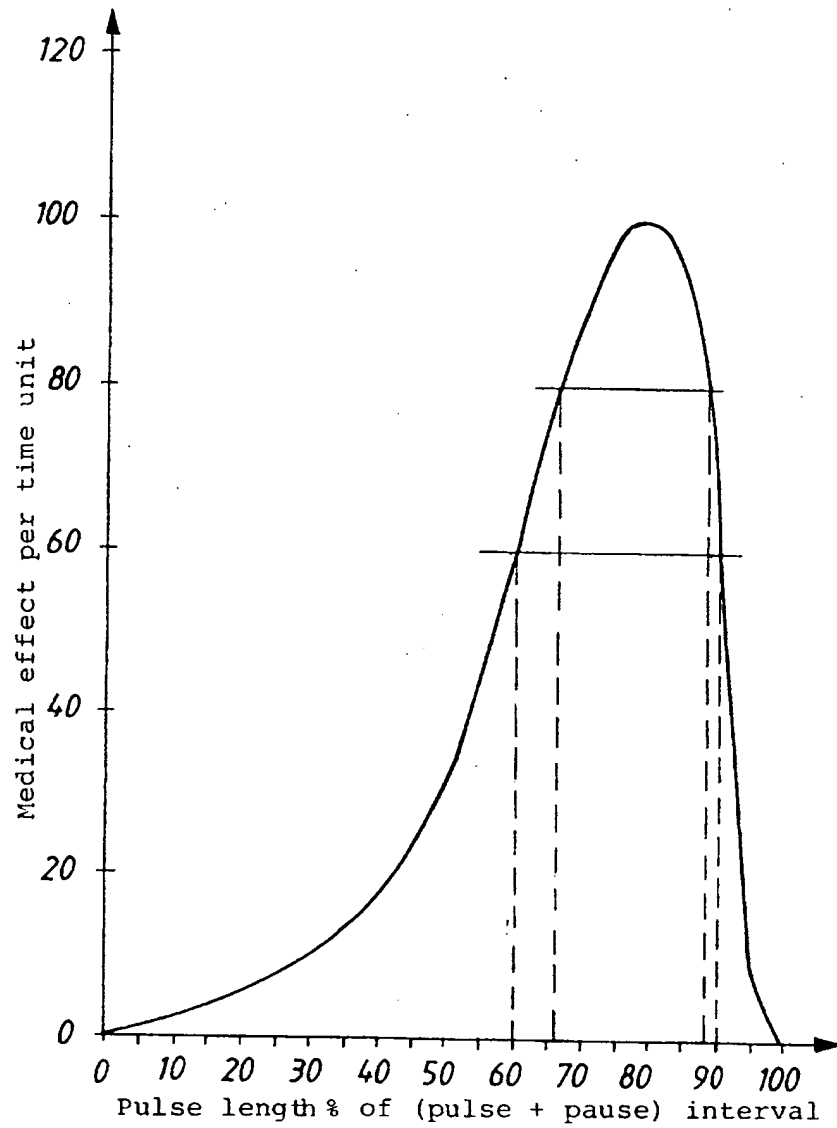
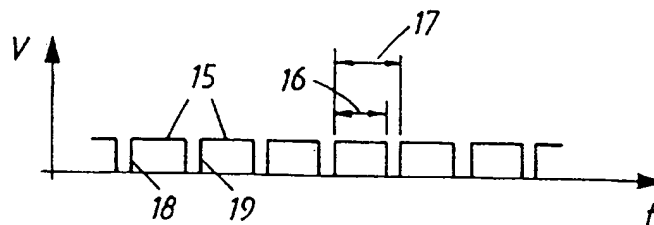


Fig. 4



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 97/00978

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A61N 5/06

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: A61N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	Lasers in Surgery and Medicine, Volume 17, 1995, Basim Mokhtar et al, "Double-Blind, Placebo-Controlled Investigation of the Effect of Combined Phototherapy/Low Intensity Laser Therapy Upon Experimental Ischaemic Pain in Humans", page 74 - page 81, see page 77, right column  --	1,2
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X	WO 9220403 A1 (LASB LASER, CORP.), 26 November 1992 (26.11.92), see pages 1-3, 6 and claims  --	1

☒ Further documents are listed in the continuation of Box C.
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25 Sept 1997	30 -09- 1997

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Information on patent family members

01/09/97

International application No.

PCT/SE 97/00978

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